

ARIZONA DEPARTMENT OF TRANSPORTATION



**MATERIALS QUALITY ASSURANCE
PROGRAM**

October 1, 1999

ADOT MATERIALS QUALITY ASSURANCE PROGRAM**Table of Contents**

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I. SCOPE

The ADOT Materials Quality Assurance Program has been established in accordance with requirements of the revised Code of Federal Regulations 23, Part 637, Subpart B - Quality Assurance Procedures for Construction. Documented herein are details of the Quality Assurance Program and applicable policies, procedures, and guidelines.

The Quality Assurance Program represents the Department's commitment to consistently provide our customers with products and services that meet mutually agreed upon requirements. The program is intended to ensure all materials incorporated into ADOT projects satisfy specification requirements and to provide the highest degree of confidence in the reliability of tests performed by laboratories for ADOT projects.

This document has been prepared for utilizing materials acceptance procedures which are now generally employed by ADOT, i.e., acceptance sampling and testing being performed by ADOT or its designated agent(s). **Appendix B** is contained herein to comply with the requirements of CFR 23, Part 637, Subpart (B), which allows the use of contractor test results in making the acceptance decision. At present, contractor testing activities are not included in the acceptance decision on a routine basis. For projects which clearly allow the use of contractor's test results in the acceptance decision, reference must be made to **Appendix B**.

The Quality Assurance Program is administered by the Materials Group Quality Assurance Section. Revisions to this program will be issued by the Quality Assurance Section through the authority of the Assistant State Engineer, Materials Group.

II. LIST OF ABBREVIATIONS

AAP	AASHTO Accreditation Program
AASHTO	American Association of State Highway and Transportation Officials
ACI	American Concrete Institute
ADOT	Arizona Department of Transportation
AMRL	AASHTO Materials Reference Laboratory
ASTM	American Society for Testing and Materials
ATI	Arizona Technical Institute
CCRL	Cement and Concrete Reference Laboratory
CFR	Code of Federal Regulations
FAPG	Federal-Aid Policy Guide
I.A.	Independent Assurance Sampling and Testing Program
ITD	Intermodal Transportation Division
NICET	National Institute for Certification in Engineering Technologies
PPD	Materials Policy and Procedure Directive
RME	Regional Materials Engineer
QA	Quality Assurance
QC	Quality Control

III. GLOSSARY OF TERMS

Acceptance Program - All factors used by the State to determine the quality of the product as specified in the contract requirements. These factors include acceptance sampling and testing, and inspection of materials and workmanship. If the contractor's test results are utilized in the acceptance decision, as explained in **Appendix B**, the acceptance program will include contractor sampling and testing along with verification sampling and testing performed by ADOT or its designated agent(s).

Acceptance Sampling and Testing - Sampling and testing performed to determine the quality and acceptability of the materials and workmanship incorporated in a project.

Certification Acceptance Projects - Federal-aid projects which are advertised, awarded, and administered by a Local Government agency which satisfies the requirements of the "ADOT Certification Acceptance Procedures".

Contractor Testing - Random sampling and testing and other operational techniques and activities that are performed by the contractor/vendor to fulfill the contract requirements. Contractor testing is normally sampling and testing performed by the contractor for quality control of his materials. As explained in **Appendix B**, if project requirements allow, the contractor may also perform sampling and testing which is used in the acceptance decision. If the contractor's sampling and testing is used in the acceptance decision, verification sampling and testing by ADOT or its designated agent(s) must be performed to validate the quality and acceptability of materials and workmanship.

Correlation Testing Program - Testing performed to check or establish variability of testing procedures and equipment between testing laboratories. ADOT requires split samples be tested by the Project Laboratory and the Regional or Central Laboratory.

Independent Assurance Sampling and Testing Program - Activities that are an unbiased and independent evaluation of sampling and testing used in the acceptance program. Independent Assurance samples and tests or other procedures shall be performed by qualified State personnel, or State designated agents such as qualified consultants, who do not have direct responsibility for contractor, acceptance, or verification sampling and testing on a project. The results of independent assurance tests are not used for determining the quality and acceptability of the materials and workmanship. Tests performed by the Materials Group Central Laboratory for use in the acceptance decision are not covered by the Independent Assurance Sampling and Testing Program.

Inspection - The process of observing, measuring, examining, testing, gauging, or otherwise evaluating materials, products, services, testing activities, and equipment.

Laboratory Technician - An employee of the laboratory who is assigned to perform the actual testing operations primarily conducted in the laboratory. Certain specifications may require technicians who are certified through appropriate certification programs determined by the Department.

Proficiency Sample Program - Homogeneous samples that are distributed and tested by two or more laboratories. The test results are compared to assure that the laboratories are obtaining results within prescribed limits of variability.

Qualified Laboratories - Laboratories which have been approved to perform testing activities for ADOT. These laboratories have met the requirements of the ADOT "System for the Evaluation of Testing Laboratories". The ADOT "Directory of Approved Materials Testing Laboratories" lists laboratories meeting this criteria.

Qualified Sampling and Testing Personnel - Personnel who meet the requirements as established by ADOT.

Quality - Consistently conforming to mutually agreed upon requirements.

Quality Assurance - All those planned and systematic activities necessary to provide adequate confidence that a product or service satisfies given requirements for quality.

Quality Assurance Program - The organizational structure, policies, responsibilities, procedures, processes, and resources utilized for implementing quality assurance activities and ensuring continued compliance with applicable standards.

Random Sample - A sample drawn from a lot in which each increment in the lot has an equal probability of being chosen. All samples used for contractor, acceptance, and verification sampling and testing shall be random samples.

Testing Laboratory - An organization that measures, examines, performs tests; or otherwise determines the characteristics, properties, and performance of materials or products. ADOT issues the "Directory of Approved Materials Testing Laboratories" which lists testing laboratories approved to perform testing activities on ADOT projects.

Vendor - A supplier of project-produced material that is not the contractor.

Verification Sampling and Testing - Random sampling and testing performed to validate the quality and acceptability of materials and workmanship when contractor's test results are utilized in the acceptance decision (See **Appendix B**). Verification sampling and testing shall be performed on independent samples obtained by qualified testing personnel of the State or its designated agent, excluding the contractor and vendor.

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V. QUALITY ASSURANCE

A. CONTRACTOR TESTING

When specified by Standard Specifications or Special Provisions, the contractor is required to perform specific sampling, testing, and other related activities. The primary purpose of contractor sampling and testing is to assure the contractor that their process is in control and producing a product satisfying ADOT contractual specifications; however, If permitted by specification, contractor testing may be used in the acceptance decision (**See Appendix B**).

Contractor sampling and testing shall be performed by qualified technicians and testing laboratories. Laboratory and technician qualification requirements are presented in the ADOT "System for the Evaluation of Testing Laboratories" (**See Appendix A**). Laboratories satisfying the ADOT "System for the Evaluation of Testing Laboratories" are listed in the ADOT "Directory of Approved Materials Testing Laboratories", issued twice a year.

The Resident Engineer has the responsibility and authority to review and approve contractor sampling and testing activities. Project personnel are also responsible for monitoring the contractor's performance and compliance with specification requirements. When requested by the Project or District, Materials Quality Assurance Section will perform an inspection of the contractor's testing laboratory in accordance with **Section VI (A)** of this manual.

B. MATERIALS ACCEPTANCE

The quality of materials and construction incorporated into ADOT construction projects are controlled by sampling and testing, and accepted based on specification compliance. Compliance with specifications is determined by acceptance sampling and testing, verification sampling and testing in the case of using the contractor's test results in the acceptance decision (**See Appendix B**), materials certification, and inspection. All materials shall be randomly sampled at prescribed frequencies as given in the Sampling Guide Schedule, **Appendix C**. Sampling and testing shall be performed by qualified laboratories and by qualified sampling and testing personnel.

Reliance should not be placed wholly on the results of sampling and testing in determining the acceptability of materials and construction work. The sampling and testing should be supplemented by sufficient visual inspection of the materials to determine whether the samples and tests are reasonably representative. In addition, there should be sufficient observation of the construction operations and processes to assure uniformly satisfactory results.

1. Acceptance Sampling and Testing

The Sampling Guide Schedule (**Appendix C**) applies to sampling frequencies only for acceptance sampling and testing. It gives the material type to be sampled, the frequency of sampling, location of samples, and testing to be performed. Acceptance samples must be obtained randomly by ADOT technicians or its designated agent.

It is the intent of the Sampling Guide Schedule to provide guidance to personnel responsible for sampling and testing materials, yet allow reasonable latitude for adapting to specific project needs. The frequency may vary for individual projects or phases of projects in accordance with job conditions, such as, the uniformity of materials at the source, the methods and equipment used, and weather conditions. The number of samples and locations from which they are taken should adequately assure or verify that the materials incorporated and construction produced are acceptable in accordance with the plans and specifications. The Engineer may direct that less acceptance sampling and testing be accomplished in particular cases he deems necessary provided concurrence from Materials Group is obtained. Conversely, the Engineer may direct that an amount of acceptance testing greater than the required minimum be done when he deems necessary.

The recommended number of acceptance samples is listed on a materials sample checklist [see **Section V(E)(1)**] issued for each project by the Quality Assurance Section. The number of samples given on the materials sample checklist is the recommended minimum derived from the project special provisions bidding schedule. For materials that are sampled on a time designated lot basis, an estimated lot quantity is used to determine the recommended number of acceptance samples.

2. Materials Certification

Acceptance of materials by "Certificate of Compliance" or "Certificate of Analysis" will be in accordance with Section 106.05 of the Standard Specifications and Section 1000 of the Materials Testing Manual.

Small quantities may be accepted on the basis of certification or based upon visual observations of the Engineer. Small quantities may be considered to be approximately 400 cubic meters (500 cubic yards) or less of processed aggregate material or approximately 18 metric tons (20 tons) of bituminous material, portland cement, or fly ash. A small quantity of portland cement concrete should be considered to be 4 cubic meters (5 cubic yards) or less. The Engineer should exercise careful judgment in the acceptance of small quantities. Considerations must include the significance of the product to the construction as well as the quantity. The recommended sizes of small quantities are to be considered approximate, not maximums.

Some materials are pre-sampled at the supplier's yard by the Regional or Central Laboratory, tested, and tagged with an ADOT green sticker containing the project number, date sampled and lab number if specification requirements are met. For materials that are green tagged, it may not be necessary to do any further sampling and testing. However, the proper laboratory should be contacted for verification of the materials acceptability.

Some materials approved for use are shown on the Department's Approved Products List. The Approved Products List is maintained by the Arizona Transportation Research Center and is available from the Engineering Records Office, 1655 West Jackson, Phoenix, Arizona, 85007, Phone (602) 255-8216. This list includes products that have been pre-tested and found acceptable for Department use.

C. INDEPENDENT ASSURANCE SAMPLING AND TESTING

The Code of Federal Regulations, Title 23 Part 637B, requires the implementation of an Independent Assurance Program. Its definition of an independent assurance program is as follows:

"Activities that are an unbiased and independent evaluation of all the sampling and testing procedures used in the acceptance program."

The independent assurance program evaluates the sampling/testing personnel and testing equipment used in acceptance of materials. The Code of Federal Regulations allows observations, split sample results, and proficiency sample results as means of evaluating testing personnel within a State's independent assurance program. Calibration checks, split sample results, and proficiency sample results are permissible inclusions to the I.A. program for evaluating acceptance testing equipment. ADOT currently evaluates laboratories' testing equipment and personnel by inspections, I.A. split samples, and proficiency samples. The independent assurance program does not directly determine the acceptability of materials.

The Regional Materials Engineers are responsible for administering the independent assurance program; they provide personnel and equipment to obtain the independent assurance samples. Communication shall be maintained between project and regional lab personnel to assure timely independent assurance sampling and testing is accomplished commensurate with project progress.

Materials requiring independent assurance sampling/testing are:

- Naturally occurring materials, such as soils and aggregates

- Mixtures containing naturally occurring materials
- Processed aggregates
- Mixtures containing processed aggregates

For the majority of construction materials produced for ADOT projects, the frequency of sampling for independent assurance remains a function of the number of samples used for acceptance on a project basis. Unless a material is represented by a very small quantity, at least one I.A. sample is required for each qualifying material type on each project.

Independent assurance samples shall be of sufficient quantity for a split to be tested by the project laboratory.

Independent Assurance testing for in-place density may consist of documented observations of the acceptance testing during routine independent assurance visits. Documentation of each observation must include, as a minimum; date of observation, a description of test location, type of density test performed, and test operator. A report of the independent assurance inspection shall be made on the "Report of Independent Assurance Sampling and Testing" form, shown in **Figure 1**, or an equivalent.

When contractor's test results are permitted by specification to be used in the acceptance decision, modifications to independent assurance sampling and testing requirements are given in **Appendix B**.

1. Frequency of Independent Assurance Sampling and Testing

The frequency of independent assurance sampling and testing is given below.

- For asphaltic concrete produced under Specifications 406, 416, or 417:
 - One independent assurance bituminous mixture sample shall be taken per 5 acceptance lots. The I.A. sample shall be taken at a different location than any acceptance sample and will not be split with the laboratory performing acceptance testing. At least one I.A. bituminous mixture sample is required for each project having less than 5 acceptance lots.
 - Independent assurance sampling and testing, other than gradation, shall be performed on mineral aggregate for the bituminous mixture at the rate of one I.A. sample for every 40 acceptance samples.
 - I.A. samples for compaction (separate cores) will not be taken.

**ARIZONA DEPARTMENT OF TRANSPORTATION
REPORT OF INDEPENDENT ASSURANCE SAMPLING AND TESTING**

Project #: _____ Resident Engineer: _____
 TRACS #: _____ Contractor: _____
 Project Name: _____ District: _____
 Material Type: _____ Sample Date: _____ I.A. Sample Rec'd Date: _____
 Sample Location: _____ Sampled By: _____
 Location of Supply: _____ I.A. Sample ID #: _____ Tested By (Lab): _____
 Lot #: _____ I.A. Split ID #: _____ Tested By (Lab): _____

SPECIFICATION TEST CHARACTERISTIC														
I.A. SAMPLE TEST RESULT														
I.A. SPLIT SAMPLE TEST RESULT														
VARIATION (I.A. SAMPLE vs. I.A. SPLIT)														
ALLOWABLE VARIATION (±)														
AVERAGE OF ACCEPTANCE TEST RESULTS														
VARIATION (I.A. SAMPLE vs. ACCEPT. AVG.)														
ALLOWABLE VARIATION (±)														

Favorable Comparison Yes ____ No ____ / Test Characteristic(s): _____

Report of In-Place Density Observation:

Description of Test Location - _____
 Type of Density Test Performed - _____
 Date of Test and Test Operator - _____
 Favorable Inspection - Yes ____ No ____ / Comments: _____

Individual Contacted and Date/Time Acceptance Lab Notified: _____

Action Taken: _____

Remarks: _____

Regional Materials Engineer: _____

(Signature and Date)

- For portland cement concrete pavement:
 - One independent assurance concrete mixture sample for compressive strength shall be taken per 4 acceptance lots. The I.A. sample shall be taken at a different location than any acceptance sample and will not be split with the laboratory performing acceptance testing. At least one I.A. concrete mixture sample for compressive strength is required for each project having less than 4 acceptance lots.
 - Independent assurance sampling and testing, other than compressive strength, shall be performed on the concrete mixture at the rate of one I.A. sample for every 40 acceptance samples.
 - Independent assurance sampling and testing shall be performed on aggregate for the concrete mixture at the rate of one I.A. sample for every 40 acceptance samples.
- For all other materials subject to I.A. sampling and testing:
 - One I.A. sample shall be taken for every 40 acceptance samples.

2. Comparison and Reporting of Independent Assurance Sampling and Testing

Each I.A. sample will normally have an I.A. split run by the ADOT acceptance lab, with some exceptions as noted below. I.A. sample results shall be promptly compared to I.A. split sample results and to the average of acceptance test results. Due to changes in material, source of supply, or approved changes in mix designs, the average of acceptance test results shall only be determined from the particular sample population for the material they represent.

- For asphaltic concrete produced under Specifications 406, 416, or 417:
 - I.A. samples of bituminous mixture are not split to the acceptance lab; there is no comparison between I.A. and I.A. Split test results.
 - The I.A. bituminous mixture sample test result is compared to the average of acceptance tests of the lot from which it was taken.
 - Each I.A. test result for samples of mineral aggregate for the bituminous mixture, other than gradation, is compared to its I.A. split result and to the average of acceptance tests.

- For portland cement concrete pavement:
 - I.A. samples for compressive strength of the concrete mixture are not split to the acceptance lab; there is no comparison between I.A. and I.A. Split test results.
 - The I.A. compressive strength test result is compared to the average of acceptance tests of the lot from which it was taken.
 - Each I.A. test result for samples of aggregate for the concrete mixture is compared to its I.A. split result and to the average of acceptance tests.
- For all other materials subject to I.A. sampling and testing:
 - Each I.A. test result is compared to its I.A. split result and to the average of acceptance tests.

For a favorable comparison each specified test characteristic must be within the allowable variations listed in **Figure 2** for "I.A. SAMPLE vs. I.A. SPLIT" and "I.A. SAMPLE vs. AVG. OF ACCEPT".

The Regional Materials Engineer is responsible to determine allowable variations for test characteristics not listed in **Figure 2**.

Comparisons of I.A. results are documented on the "Report of Independent Assurance Sampling and Testing" form, shown in **Figure 1**, or an equivalent. An example of its use is shown in **Figure 3**. A report with unfavorable comparisons must be accompanied by documentation of an investigation and findings determining reasons for the unfavorable comparison of test results. Results of the independent assurance testing, comparisons, and findings for any unfavorable comparisons shall be communicated by the Regional Materials Engineer to the Resident Engineer/Project Lab and Materials Group within 5 working days of receiving the sample in the I.A. testing laboratory.

When Central Lab performs testing of independent assurance samples, the results will be communicated to the Regional Materials Engineer who will notify the Resident Engineer within 5 working days of receipt of the sample by Central Lab.

When an I.A. split is used as an acceptance sample, it is recorded as an acceptance test on the project Materials Sample Checklist.

**INDEPENDENT ASSURANCE AND CORRELATION TESTING
ALLOWABLE VARIATIONS (±)**

PORTLAND CEMENT CONCRETE			SOILS AND AGGREGATES		
TEST	I.A. SAMPLE VS. I.A. SPLIT	I.A. SAMPLE VS. AVG. OF ACCEPT.	TEST	I.A. SAMPLE VS. I.A. SPLIT	I.A. SAMPLE VS. AVG. OF ACCEPT.
Coarse Aggregate Gradation			Gradation, except for Portland Cement Concrete and Bituminous Mixtures		
+25.0 mm (+1")	4	8	+ 25.0 mm (+1")	4	6
25.0 mm (1")	4	8	25.0 mm (1")	4	6
19.0 mm (3/4")	4	8	19.0 mm (3/4")	4	6
12.5 mm (1/2")	4	8	12.5 mm (1/2")	4	6
9.5 mm (3/8")	4	8	9.5 mm (3/8")	4	6
6.3 mm (1/4")	4	6	6.3 mm (1/4")	4	6
4.75 mm (No. 4)	4	6	4.75 mm (No. 4)	4	6
2.36 mm (No. 8)	4	4	2.36 mm (No. 8)	4	6
Fine Aggregate Gradation			1.18 mm (No. 16)	4	6
4.75 mm (No. 4)	4	4	425 µm (No. 40)	3	5
1.18 mm (No. 16)	3	4	75 µm (No. 200)	1.5	1.5
300 µm (No. 50)	3	3	Sand Equivalent	6	9
150 µm (No. 100)	3	3	Flakiness Index	3	5
75 µm (No. 200)	1.5	1.5	Uncompacted Void Content	4	6
Air Content, percent	0.5	N/A	pH	0.4	N/A
Slump, mm (inches)	13 (1/2")	N/A	Optimum Moisture, percent	1.0	N/A
28-Day Strength	15% of	N/A	Proctor Density, kg/m ³ (pcf)	32 (2.0)	N/A
(See Notes 3 and 4 below.)	specified		Fract. Coarse Agg. Particles	28% of	N/A
	required		(See Note 4 below.)	specified	
	strength		Plasticity Index	requirement	
			(See Note 4 below.)	20% of	N/A
				specified	
				requirement	
				or if range,	
				20% of	
				midpoint of	
				specified	
				range	
BITUMINOUS MIXTURES					
TEST	I.A. SAMPLE VS. I.A. SPLIT	I.A. SAMPLE VS. AVG. OF ACCEPT.			
Mineral Aggregate Gradation					
+19.0 mm (+3/4")	4	6			
19.0 mm (3/4")	4	6			
12.5 mm (1/2")	4	6			
9.5 mm (3/8")	4	6			
4.75 mm (No. 4)	4	6			
2.36 mm (No. 8)	4	6			
600 µm (No. 30)	2	3			
425 µm (No. 40)	2	3			
75 µm (No. 200)	1.0	1.5			
Percent Asphalt	0.4	0.6			
Density, kg/m ³ (pcf)	32 (2.0)	40 (2.5)			
Voids, percent	1.5	2.0			
Marshall Stability					
Newtons	5350	6650			
(Pounds Force)	(1200)	(1500)			

Note 1: Use applicable test characteristics specified for material being tested.

Note 2: "I.A. SAMPLE VS. I.A. SPLIT" is to be used for correlation testing comparison.

Note 3: For concrete strength requirements given in megapascals, the allowable variation shall be based on the percentage of specified required strength expressed in kilopascals.

Note 4: Allowable variations based on a percentage of specified requirement or midpoint of specified range shall be rounded if necessary to the nearest whole number.

**REGIONAL MATERIALS ENGINEER TO DETERMINE ALLOWABLE VARIATIONS
FOR TEST CHARACTERISTICS NOT SHOWN ABOVE.**

Figure 2

**ARIZONA DEPARTMENT OF TRANSPORTATION
REPORT OF INDEPENDENT ASSURANCE SAMPLING AND TESTING**

Project #: F-099-9(9) Resident Engineer: FRANK BOSSY
 TRACS #: H 0999 09 C Contractor: ABC CONSTRUCTION
 Project Name: SNOW CANYON - LITTLE LAKE District: FLAGSTAFF
 Material Type: MA - 3/4" AC (416 SPECIAL MIX) Sample Date: 12-22-99 I.A. Sample Rec'd Date: 12-23-99
 Sample Location: COLD FEED Sampled By: BOB TESTER
 Location of Supply: XYZ COMMERCIAL I.A. Sample ID #: 99-136 Tested By (Lab): REGIONAL
 Lot #: E I.A. Split ID #: 99-78 Tested By (Lab): PROJECT

SPECIFICATION TEST CHARACTERISTIC	Sand Equiv.	Fract. Part.	Uncomp. voids												
I.A. SAMPLE TEST RESULT	64	78	X 48												
I.A. SPLIT SAMPLE TEST RESULT	67	87	46												
VARIATION (I.A. SAMPLE vs. I.A. SPLIT)	3	9	2												
ALLOWABLE VARIATION (±)	6	20	4												
AVERAGE OF ACCEPTANCE TEST RESULTS	60	73	47												
VARIATION (I.A. SAMPLE vs. ACCEPT. AVG.)	4	5	1												
ALLOWABLE VARIATION (±)	9	N/A	6												

Favorable Comparison Yes ☒ No ☐ / Test Characteristic(s): E

Report of In-Place Density Observation:

Description of Test Location - E

Type of Density Test Performed - E

Date of Test and Test Operator - E

Favorable Inspection - Yes ☐ No ☐ / Comments: E

Individual Contacted and Date/Time Acceptance Lab Notified: TED HEADMAN 12-29-99 11:45 AM

Action Taken: E

Remarks: E

D. CORRELATION TESTING

Correlation testing is a quality assurance activity conducted to supplement independent assurance sampling and testing. Correlation testing provides a method to isolate problems that originate from sample splitting or testing error and is typically conducted between the Project Lab and Regional Lab.

Materials requiring correlation testing are:

- Naturally occurring materials, such as soils and aggregates
- Mixtures containing naturally occurring materials
- Processed aggregates
- Mixtures containing processed aggregates

When contractor's test results are permitted by specification to be used in the acceptance decision, as addressed in **Appendix B**, correlation testing will not be performed.

1. Frequency of Correlation Testing

At a prescribed frequency, a representative split of acceptance samples taken on the project is obtained for correlation testing. Correlation split samples are taken at the frequency given below. The correlation split samples shall be properly identified and promptly submitted to the Regional Lab for testing. The correlation split will be of sufficient size for the Regional Lab to duplicate the testing that is performed at the Project Lab.

- For asphaltic concrete produced under Specifications 406, 416, or 417:
 - Correlation testing is not performed on the bituminous mixture.
 - Correlation testing, other than gradation, shall be performed on mineral aggregate materials for the bituminous mixture. A correlation split shall be obtained from the first acceptance sample, and subsequent correlation testing is then performed at the frequency of one correlation sample split being obtained from every fifth acceptance sample.

- For portland cement concrete (Any Class - P, S, B, or U):
 - No correlation testing is performed on portland cement concrete mixtures.
 - Correlation testing shall be performed on the aggregate materials for the concrete mixture. A correlation split shall be obtained from the first acceptance sample, and subsequent correlation testing is then performed at the frequency of one correlation sample split being obtained from every fifth acceptance sample.
- For all other materials subject to correlation testing:
 - A correlation split shall be obtained from the first acceptance sample, and subsequent correlation testing is then performed at the frequency of one correlation sample split being obtained from every fifth acceptance sample.

2. Comparison and Reporting of Correlation Testing

The Regional Materials Engineer or his representative will compare the results of tests performed on the acceptance sample and the correlation split. An evaluation must be made regarding the comparison of this data using **Figure 2** as a reference. For a favorable comparison, each specified test characteristic must be within the allowable variation shown for "I.A. SAMPLE vs. I.A. SPLIT". If there is an unfavorable comparison, an investigation should be initiated to determine the cause of the disparity. The investigation may include an inspection of the equipment used to perform both tests, a discussion with the test operators regarding their knowledge of the procedure, or testing by exchanging samples if sufficient material is available. When the problem is isolated, the steps taken to resolve it shall be documented. The results of the correlation testing, comparisons, and the findings for any unfavorable comparisons are to be recorded on the "Report of Correlation Testing" form presented in **Figure 4**, or an equivalent form. An example of its use is given in **Figure 5**.

The Regional Materials Engineer is responsible to determine allowable variations for test characteristics not listed in **Figure 2**.

The results of the correlation testing, comparisons, and findings of any unfavorable comparisons shall be communicated by the Regional Materials Engineer to the Resident Engineer/Project Lab within five working days of receipt of the sample in the correlation testing laboratory.

ARIZONA DEPARTMENT OF TRANSPORTATION REPORT OF CORRELATION TESTING

Project #: _____ Resident Engineer: _____
 TRACS #: _____ Contractor: _____
 Project Name: _____ District: _____
 Material Type: _____ Sample Date: _____ Correlation Split Rec'd Date: _____
 Sample Location: _____ Sampled By: _____
 Location of Supply: _____ Correlation Split I.D. #: _____ Tested By (Lab): _____
 Lot #: _____ Acceptance Sample I.D. #: _____ Tested By (Lab): _____

SPECIFICATION TEST CHARACTERISTIC														
CORRELATION SPLIT TEST RESULT														
ACCEPTANCE SAMPLE TEST RESULT														
VARIATION (CORRELATION vs. ACCEPTANCE)														
ALLOWABLE VARIATION (±)														

Favorable Comparison Yes ____ No ____ / Test Characteristic(s): _____

Individual Contacted and Date/Time Acceptance Lab Notified: _____

Action Taken: _____

Remarks: _____

Figure 4

ARIZONA DEPARTMENT OF TRANSPORTATION
REPORT OF CORRELATION TESTING

Project #: F-099-9 (9) Resident Engineer: FRANK BOSSY
 TRACS #: H 9999 09C Contractor: ABC CONSTRUCTION
 Project Name: SNOW CANYON - LITTLE LAKE District: FLAGSTAFF
 Material Type: AGGREGATE BASE - CLASS 3 Sample Date: 11-16-99 Correlation Split Rec'd Date: 11-16-99
 Sample Location: WINDROW - STATION 640+00 - LIFT 1 Sampled By: JOE DOGOOD
 Location of Supply: XYZ COMMERCIAL Correlation Split I.D. #: 99-316 Tested By (Lab): REGIONAL
 Lot #: E Acceptance Sample I.D. #: 99-239 Tested By (Lab): PROJECT

SPECIFICATION TEST CHARACTERISTIC	1"	3/4" X 3/8"	#8	#200	P.I.	FRACT. PART.							
CORRELATION SPLIT TEST RESULT	100	95	75	40	3.4	1	43						
ACCEPTANCE SAMPLE TEST RESULT	100	94	71	37	2.8	NP	38						
VARIATION (CORRELATION vs. ACCEPTANCE)	0	1	4	3	0.6	1	5						
ALLOWABLE VARIATION (±)	4	4	4	4	1.5	1	8						

Favorable Comparison Yes ☒ No ☐ / Test Characteristic(s):Individual Contacted and Date/Time Acceptance Lab Notified: Ted Headman 11-19-99 2:30 pmAction Taken: E

Remarks:

Regional Materials Engineer:

Matt Mann 11-19-99
(Signature and Date)

E. FINAL CERTIFICATION OF MATERIALS INCORPORATED IN THE WORK

The following information in this section supersedes Materials Group Policy and Procedure Directive No. 92-6. It outlines the procedure to be followed in certifying that materials incorporated in the work were in conformity with the approved plans and specifications.

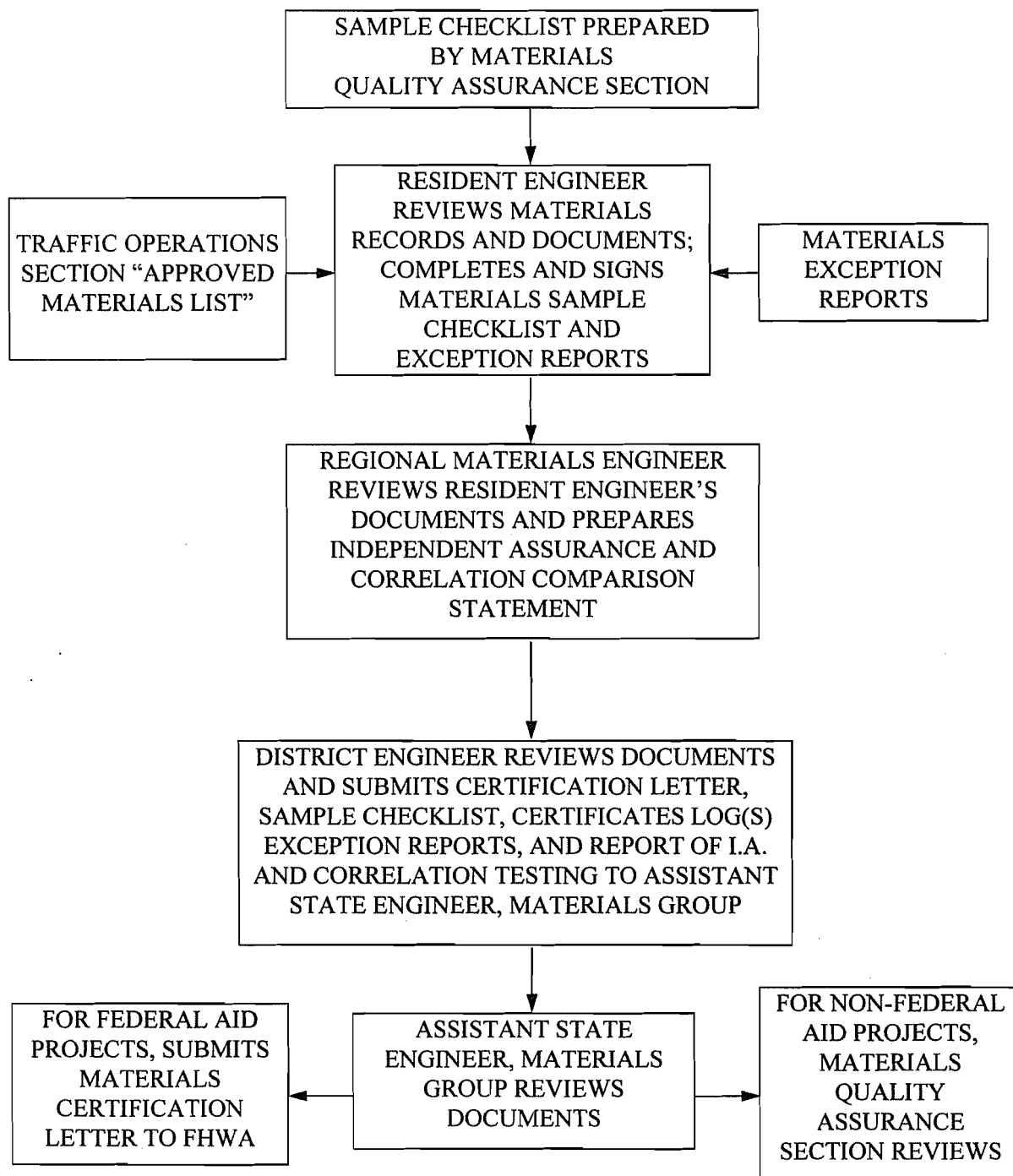
A "Materials Certification Flow Chart" is given in **Figure 6**. This flow chart provides a brief illustration of the requirements given herein.

1. Materials Sample Checklist

Materials Group, Quality Assurance Section, will originate the project "Materials Sample Checklist" recommending the number of acceptance, independent assurance, and correlation samples to be taken for each material. Materials which are not listed, but are accepted by testing shall be added to the sample checklist by the project. "As-Built" quantities which are substantially different from plans quantities shall be noted on the sample checklist and the Quality Assurance Section contacted for revised sampling and testing requirements. A blank sample checklist and cover letter are given in **Figures 7 through 9**. Upon completion of each project, the sample checklist shall be completed and signed by the Resident Engineer. A copy of the completed and signed Certificate Log(s) shall be attached to the Materials Sample Checklist. These items shall be submitted to the Regional Materials Engineer for his/her review. If acceptable, the Regional Materials Engineer signs the completed Materials Sample Checklist. If necessary, the Materials Sample Checklist shall be returned to the Resident Engineer for correction.

2. Materials Records

The materials records for each project will be reviewed by the Resident Engineer. Any material represented by failing tests which has been incorporated into the work is considered an exception to the plans and specifications. Each exception, including exceptions which are covered by supplemental agreements, must be listed and explained in a separate document entitled "Materials Exception Report". The exception report shall identify the project number, the material type, tests failed and an explanation of the corrective action taken, including reference to any supplemental agreement that provided for a change in specifications and/or acceptance of the material. The exception report shall be signed by the Resident Engineer and submitted to the Regional Materials Engineer for his/her review. If necessary, it shall be returned to the Resident Engineer for correction.

MATERIALS CERTIFICATION FLOW CHART**Figure 6**

ARIZONA DEPARTMENT OF TRANSPORTATION

OFFICE MEMO

(Date)

TO:

FROM: **RANDOLPH J. ALLENSTEIN**
Quality Assurance Engineer
Materials Group (068-R)

RE: **PROJECT NO.**

Materials Group has prepared the following checklist of the materials to be used in constructing this project which require testing for approval. The number of recommended samples for acceptance (ACCP), independent assurance (IAS), and correlation (CORR) testing are derived from the "Materials Quality Assurance Program" (Series 900 of the Materials Testing Manual). The recommendations are considered minimum for the plan quantity. Documentation must be provided if the actual number of samples differs from that recommended. All materials used on the project which require testing should be listed. Materials used which were not originally listed should be added.

Acceptance samples taken by the project are to be recorded under the ACCP SAMPLES TAKEN BY PROJECT column, regardless of where the tests are performed. The number of samples tested shall be recorded in the appropriate column. Acceptance testing performed by the project is to be recorded under the ACCP SAMPLES TESTED BY PROJECT column, acceptance testing performed by the Regional Lab is to be recorded under the REGIONAL ACCP column, and acceptance testing performed by the Central Lab is to be recorded under the CENTRAL ACCP column. Independent assurance sample splits used for acceptance testing are to be recorded under the ACCP column for the lab performing the acceptance testing. Correlation testing performed by the Regional Lab is to be recorded in the REGIONAL CORR column. Independent assurance sample testing is to be recorded under the column for the lab performing the testing, i.e., REGIONAL IAS or CENTRAL IAS columns.

Upon completion of the project, the Materials Sample Checklist shall be signed and submitted to the Regional Materials Engineer for review and signature. A copy of the completed and signed Certificate Log(s) shall be attached to the Materials Sample Checklist. These documents shall be forwarded to the District Engineer for review and approval. The District Engineer will then forward them to the Assistant State Engineer, Materials Group.

RJA:laa

cc:

Regional Materials Engineer
Regional Lab ()

ADOT MATERIALS QUALITY ASSURANCE PROGRAM

October 1, 1999

PROJECT NUMBER:

[illegible]

* Small quantity, no samples required.

Figure 8

ARIZONA DEPARTMENT OF TRANSPORTATION
MATERIALS SAMPLE CHECKLIST

PROJECT NUMBER: _____

ITEM NUMBER	MATERIAL	PLAN QUANTITY	ACTUAL QUANTITY IF VARIES FROM PLAN QUANTITY	NUMBER OF SAMPLES				NUMBER OF SAMPLES TESTED					
				RECOMMENDED			PROJECT		REGIONAL			CENTRAL	
				A	I	C	ACCP	ACCP	A	I	C	A	I
				C	A	O	SAMPLES	SAMPLES	C	A	O	C	A
				C	S	R	TAKEN	TESTED	C	S	R	C	S
				P		R	BY PROJECT	BY PROJECT	P		R	P	

* Small quantity, no samples required.

- NOTE: A. One acceptance sample per 900 Mg (1000 T). Minimum one IAS per 40 acceptance samples.
 B. One acceptance sample per 75 m³ (100 CY). Minimum one IAS per 40 acceptance samples.
 C. Five samples per lot for acceptance. Minimum one IAS per 20 acceptance samples for class P concrete. Minimum one IAS per 40 acceptance samples for CTB.
 D. Minimum one gradation sample per shift. Minimum one IAS per 40 acceptance samples.

Mg = megagram = metric ton

REMARKS: _____

This is to certify that all materials, except those materials accepted by certification and those where no samples are required, were properly sampled and tested.

Report prepared by _____ Date _____
 Resident Engineer (Signature and Date) _____ Reviewed by: _____
 Regional Materials Engineer (Signature and Date)

The Resident Engineer will assure and maintain information in the project files that all traffic engineering items installed on the project are in compliance with the contract documents and the "Approved Materials List" issued by Traffic Operations Section.

The Regional Materials Engineer is required to furnish the District Engineer with a statement concerning the adequacy of the Independent Assurance Sampling and Testing Program, and the Correlation Testing Program. This statement must address the number of independent assurance and correlation samples that were actually tested in comparison to the number of samples recommended to be obtained. In addition, the Regional Materials Engineer's statement must address the comparison of independent assurance and correlation test results to the acceptance testing. Any statement concerning the lack of favorable comparison must be supported with a reasonable explanation, including the corrective action taken.

3. Certification of Materials for Federal-Aid Projects

The completed sample checklist, certificate log(s), exception reports, and report of independent assurance and correlation testing shall be forwarded to the District Engineer.

The District Engineer will provide the Assistant State Engineer, Materials Group, with the aforementioned documents and a statement which will include as a minimum:

"The results of the tests used in the acceptance program indicate that the materials incorporated in the construction work, and the construction operations controlled by sampling and testing, were in conformity with the approved plans and specifications.

In addition, the results of independent assurance sampling and testing, and correlation testing compare favorably to the samples and tests that are used in the acceptance program."

The District Engineer's statement should also state whether exceptions to the plans and specifications were identified or not. The Assistant State Engineer, Materials Group, will review the documentation furnished by the District Engineer. Based on this documentation, the Assistant State Engineer, Materials Group, will prepare and submit the certification letter to the Federal Highway Administration.

4. Certification of Materials for Local Government Federal-Aid Projects

Materials certification for self-administered local government projects will be conducted in accordance with "Materials Sampling and Testing", pages 19 and 20 of *A Guide for Local Governments to Self-Administer Federal-Aid Projects - August 1984*, revised as follows:

(a) The local agency engineer will be responsible for sampling and testing materials in accordance with the ADOT Materials Testing Manual and the Specifications.

(b) Independent Assurance Sampling and Testing and Correlation Testing will be performed by the ADOT personnel as the work progresses.

(c) Independent Assurance and Correlation samples taken by ADOT personnel, as outlined in item (b) above do not relieve the local agency's engineer of the responsibility for sampling and testing of materials in accordance with item (a) above.

(d) At the completion of the project, the local agency engineer will furnish the completed materials sample checklist, certificate log(s), exception reports, report of independent assurance and correlation testing, and a certification letter for all materials incorporated in the work. These documents will be submitted to the ADOT District Engineer who will review the documentation and forward it to the Assistant State Engineer, Materials Group.

(e) Based on the documentation received from the local agency's engineer and the ADOT District Engineer, the Assistant State Engineer, Materials Group, will prepare and submit the certification letter to the Federal Highway Administration. Accompanying that certification letter will be a copy of the certification letter received from the agency engineer.

5. Certification of Materials for Non Federal-Aid Projects

A letter of certification along with the completed materials sample checklist, certificate log(s), exception reports, and report of independent assurance and correlation testing shall be submitted by the District Engineer to the Assistant State Engineer, Materials Group as required for the CERTIFICATION OF MATERIALS FOR FEDERAL-AID PROJECTS shown herein. The Materials Group, Quality Assurance Section will review the submitted documents and prepare the final materials certification and maintain the documentation on file.

VI. LABORATORY QUALIFICATIONS

The ADOT "System for the Evaluation of Testing Laboratories," given in **Appendix A**, details the requirements that laboratories must satisfy to be approved for performing testing activities for ADOT. In addition to being AASHTO certified through the AASHTO Accreditation Program, laboratories must participate in the ADOT Laboratory Inspection Program and the ADOT Proficiency Sample Program. AAP accreditation and ADOT approval must be received for all test methods that are to be performed on ADOT projects.

A. ADOT LABORATORY INSPECTION PROGRAM

The Quality Assurance Section of Materials Group administers an inspection program of all materials testing laboratories performing testing activities for the Department. Compliance to test procedures and equipment requirements are included in the inspection. All laboratories are inspected on an approximate 18-month cycle.

1. Participation

All independent, contractor, materials supplier, government, and other testing laboratories desiring to perform testing activities for ADOT must submit to an inspection as specified in the "System for the Evaluation of Testing Laboratories". The inspection considers those elements of service that the respective laboratory proposes to offer to the Department. This requirement includes laboratories submitting asphaltic concrete mix designs and those performing acceptance and referee testing for the Department.

The Quality Assurance Section will inspect only laboratories that are involved, or seeking involvement, in an activity related to the design or construction of an ADOT project.

2. Equipment Inspection

The laboratory equipment inspection will consist of checking dimensional, calibration, and specification conformance of all apparatus and equipment required by the test procedures contained in the Materials Testing Manual or other applicable specifications. Equipment related documentation, required by AASHTO R18, is also checked during this inspection. This inspection is not a calibration service for non-ADOT laboratories. Any equipment found unacceptable must be repaired, properly calibrated, or removed from service at the expense of the owner laboratory. Laboratory facilities will also be checked for compliance with applicable standards, such as, proper temperature and humidity control.

3. Procedural Inspection

The procedural inspection serves as a tool to evaluate the performance of laboratory technicians when performing tests in accordance with the ADOT Materials Testing Manual or other applicable specifications. Arizona, AASHTO, and ASTM test methods referenced in the Materials Testing Manual will be observed. In the event that Arizona Test Methods deviate from those given in a similar AASHTO or ASTM procedure, the Materials Testing Manual will govern.

4. Procedure and Report

The equipment and procedural inspections are normally conducted simultaneously; however, circumstances may dictate independent inspections. The inspection formats will generally conform to the techniques employed by AMRL and CCRL, as appropriate. When a departure from the requirements of a test method is observed by the inspectors, they will point it out to the laboratory personnel so that immediate corrections can be made if possible. The inspectors will present a summary of their findings and identify deficiencies requiring corrective action at an informal exit review where any deficiencies discovered can be discussed openly. It is requested that the Laboratory Manager and Supervising Engineer be present at the exit review.

A written inspection report will be issued by the Quality Assurance Section to the laboratory that has been inspected. The laboratory must provide the Quality Assurance Engineer with satisfactory responses to the noted deficiencies within 30 days of the report issuance. The responses must provide satisfactory evidence that all significant deficiencies were corrected or that corrective action is in progress. The laboratory's inspection and responses will be considered when evaluating ADOT eligibility.

B. ADOT PROFICIENCY SAMPLE PROGRAM

The Quality Assurance Section administers the ADOT Materials Proficiency Sample Program. The program allows participants to evaluate the reliability of their testing by comparing their test results to a population of test data generated by all participants. Specified routine tests are performed in accordance with standard Arizona and AASHTO test methods by each participating laboratory on carefully prepared samples of highway construction materials and the test results reported to ADOT for review and analysis.

1. Participation

Participation in the ADOT Proficiency Sample Program is available to all interested materials testing laboratories. Regular participation in the program is required for all laboratories performing any testing activities for the Department, as specified in the

"System for the Evaluation of Testing Laboratories". Participation by laboratories not performing testing activities for the Department is voluntary.

2. Proficiency Samples

Proficiency samples are carefully prepared to be as homogeneous as possible to minimize the effect of material variability in evaluating the results. Each sample is sequentially numbered and, using random numbers, a set of samples is allocated to each participant. To permit an estimate of single-operator precision, instructions are given for a single test operator to conduct all repetitions of an individual test method; however, it is not required that the same person conduct all test methods prescribed for a set of proficiency samples.

The program generally provides 9 to 12 proficiency samples per year. Typically, the material types and routine tests performed are:

- **Soil** - Gradation, Atterberg limits (PI), pH, resistivity, soluble salts, and moisture-density relations.
- **Fine Aggregate** - Gradation, sand equivalent, fine specific gravity, and absorption.
- **Coarse Aggregate** - Gradation, specific gravity, absorption, L.A. Abrasion, unit weight, fractured faces, and flakiness index.
- **Asphaltic Concrete** - Asphalt content, maximum theoretical specific gravity/density (Rice), Marshall stability/flow, Marshall compaction/density, gyratory compaction/density, moisture content, and gradation of mineral aggregate.
- **Portland Cement Concrete** - 7 and 28 day compressive strengths of prepared cylinders.
- **Asphaltic Concrete Mix Design** - Immersion compression.
- **Asphalt Cement/Binder** - Rotational viscosity, pressurized aging, flash point, bending beam rheometer, direct tension, dynamic shear rheometer.

- **Emulsified Asphalt** - Saybolt-Furol viscosity, % residue, % uncoated particles, absolute viscosity, and sieve test.
- **Reinforcing steel** - Nominal weight, yield strength, tensile strength, and % elongation.

3. Analysis/Reporting of Proficiency Sample Results

Proficiency sample test results are required to be submitted promptly upon completion of testing to the Quality Assurance Section no later than a specified date. All test data submitted is analyzed similar to the method presented in the paper: *"Statistical Evaluation of Interlaboratory Cement Tests"* by J. R. Crandall and R. L. Blaine, Volume 59 (1959) of the Proceedings of the American Society for Testing and Materials. A final report summarizing the results of the analysis is issued for each proficiency sample. The final report presents a statistical summary of results for the population of test data and a tabulation of each laboratory's individual data. Statistical characteristics presented are averages, standard deviations, coefficients of variation, z-scores, and performance ratings. The z-score is equal to the number of standard deviations the data departs from the population mean. A laboratory's performance ratings are based on the following scale:

Rating	Standard Deviations from Mean (z-score)
5	0 to ≤ 1.0
4	> 1.0 to ≤ 1.5
3	> 1.5 to ≤ 2.0
2	> 2.0 to ≤ 2.5
1	> 2.5 to ≤ 3.0
0	> 3.0; eliminated from analysis
N	No data received

All data submitted is initially reviewed and analyzed. Invalid data is eliminated, then the remaining data is reanalyzed and presented in the proficiency sample final report. A single low rating, or a pair of low ratings, is not considered significant. A continuing trend of low ratings for a test characteristic should cause a laboratory to investigate its equipment and test methodology.

The "History of Z – Scores" charts accompany each proficiency sample final report. These charts show a laboratory's performance trend for each test characteristic. In addition, scatter diagrams are included in each proficiency sample report for each test characteristic. A scatter diagram shows each laboratory's reported results as a point on the graph, relative to the population averages for that test.

Participating laboratories are required to investigate the reason for discrepancies when their results are 2 or more standard deviations from the population average values (rating of 2 and less). The laboratories must report findings and corrective actions to the Quality Assurance Section within 30 days of the final report issuance. The performance and adequacy of the laboratory's responses will be considered when evaluating the eligibility of the laboratory to conduct testing activities for ADOT.

C. CONFLICT OF INTEREST

In order to avoid a conflict of interest, any qualified laboratory shall perform only one of the following types of testing on the same project: Acceptance or verification testing, contractor testing, Independent Assurance testing, or dispute resolution (referee) testing.

VII. SAMPLING AND TESTING PERSONNEL QUALIFICATION REQUIREMENTS

Personnel supervising or performing testing activities for ADOT must meet the qualification requirements as given in the ADOT "System for the Evaluation of Testing Laboratories" (see **Appendix A**).